INSTRUCTION MANUAL FOR

LK-340_LK-345
LK-340A LK-345A

POWER SUPPLY SERIES

LAMBDA ELECTRONICS INC.

IM-LK-34

INSTRUCTION MANUAL

FOR

REGULATED POWER SUPPLIES

MODELS LK-340A—LK-345A

MODELS LK-340—LK-345

BEARING SERIAL NO.

PREFIXES A - D

This manual provides instructions intended for the operation of Lambda power supplies, and is not to be reproduced without the written consent of Lambda Electronics. All information contained herein applies to all metered and non-metered LK half-rack models unless otherwise specified.

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SPECIFICATIONS AND FEATURES

The following specifications apply for all non-metered and metered LK half-rack models.

DC OUTPUT--Voltage regulated for line and load

Voltage Range.....TABLE I

VOLTAGE RANGE

MODEL	LK-340 LK-340A	LK-341 LK-341A	LK-342 LK-342A	LK-343 LK-343A	LK-344 LK-344A	LK-345 LK-345A
VOLTAGE RANGE VDC	0-20	0-20	0-36	0-36	0-60	0-60

Multi-Current Ranges.....Current range must be chosen to suit the appropriate maximum ambient temperature. Current ratings apply for entire voltage range with input frequency 57-63 Hz. Derate current 10% for 50 Hz input frequency.

TABLE II

MODEL	CURRENT RANGE AT AMBIENT OF:			
	40°C	50°C	60°C	71°C
LK-340, LK-340A	0- 8.0A	0- 7.0A	0- 6.1A	0- 4.9A
LK-341, LK-341A	0-13.5A	0-11.0A	0-10.0A	0- 7.7A
LK-342, LK-342A	0- 5.2A	0- 5.0A	0- 4.5A	0- 3.7A
LK-343, LK-343A	0- 9.0A	0- 8.5A	0- 7.6A	0- 6.1A
LK-344, LK-344A	0- 4.0A	0- 3.5A	0- 3.0A	0- 2.5A
LK-345, LK-345A	0- 6.0A	0- 5.2A	0- 4.5A	0- 4.0A

REGULATED VOLTAGE OUTPUT

Regulation (line)..... 0.015 percent or 1.0 millivolt, whichever is greater for input variations from 105-132 or 132-105 volts AC

Regulation (load)..... 0.015 percent or 1.0 millivolt, whichever is greater for load variations from 0 to full load or full load to 0

Remote Programming

External Resistor..... Nominal 200 ohms/volt output

Programming Voltage..... One-to-one voltage change

Ripple and Noise..... 0.5 millivolts rms with either positive or negative terminal grounded

Temperature Coefficient... Change in output voltage less than 0.015%/°C

DC OUTPUT--Current regulated for line and load; Automatic crossover with voltage limit

Multi-Current Ranges..... Current range must be chosen to suit the appropriate maximum ambient temperature. Current ratings apply for entire voltage range. For maximum current range see Table II. Minimum current 5% of 40° rating in Table II.

Voltage Range..... For voltage range see Table I; voltage ratings apply for entire current range.

REGULATED CURRENT OUTPUT; AUTOMATIC CROSSOVER

Regulation (line)..... 0.1% or 10 milliamperes, whichever is greater, for input variations from 105-132 or 132-105 volts AC

Regulation (load)..... 0.1% or 10 milliamperes, whichever is greater, for load voltage changes from 0 to rated VDC or rated VDC to 0 volts.

AC INPUT--105-132 volts AC at 57-63 Hz. For input power see Table III. Ratings apply for 57-63 Hz; for other input frequencies consult factory.

TABLE III

INPUT POWER WATTS*

INPUT POWER	MODEL
324 watts	LK 340A, LK 340
580 watts	LK 341A, LK 341
340 watts	LK 342A, LK 342
625 watts	LK 343A, LK 343
350 watts	LK 344A, LK 344
630 watts	LK 345A, LK 345

*With output loaded to full 40°C rating and input voltage 132 volts at 57-63 Hz.

OVERLOAD PROTECTION

Thermal..... Thermostat, resets automatically when over-temperature condition is eliminated.

Electrical

External Overload Protection .. Adjustable, automatic, electronic current-limiting circuit, settable to 105 percent of rated current; limits output current to preset limit for protection of load and power supply when external overloads and short circuits occur.

Internal..... "SLO-BLO" fuse F1 protects the AC input circuit. Overload of the supply does not cause fuse failure.

"STANDARD" fuse F2 protects the load from excessive output current that can be caused by internal circuit failure.

MODEL	LK 340A LK 340	LK 341A LK 341	LK 342A LK 342	LK 343A LK 343	LK 344A LK 344	LK 345A LK 345
F1	10A	15A	10A	20A	15A	20A
F2	15A	30A	10A	20A	10A	15A

INPUT AND OUTPUT CONNECTIONS-- Heavy duty terminal block on rear of chassis with 5-foot, 3-wire detachable line cord for all models.

OVERSHOOT..... No overshoot of output voltage under conditions of power turn-on, power turn-off, or power failure.

OPERATING AMBIENT TEMPERATURE RANGE AND DUTY CYCLE--Continuous duty from $0^{o}C$ to $71^{o}C$ ambient with corresponding load current ratings for all modes of operation

STORAGE TEMPERATURE- $-55^{o}C$ to $+85^{o}C$
(non-operating)

METERS-Voltmeter and ammeter on metered suffix (FM) models

CONTROLS

DC output controls.....Coarse and fine voltage controls and coarse and fine current controls permit adjustment of DC output; located on front panel of all models

Remote Sensing..... Provision is made for remote sensing to eliminate effect of power output lead resistance on DC regulation

Power..... Panel mounted switch and indicator light for all units.

PHYSICAL DATA

Size..... 5-3/16"H x 8-3/8"W x 16-1/2"D

Weight..... 35 lbs. net; 41 lbs. shipping wt.

Panel Finish ..... Brushed aluminum clear anodized panels with grey inlay (standard); special finishes available to customer's specifications at moderate surcharge.

MOUNTING:

Laboratory bench, table top . Bumpers secured to the base of all LK models permit proper circulation of air through the unit. Removal of bumpers will restrict free-flow of air through the unit; avoid removing bumpers.

ACCESSORIES

Rack Adapters..... Rack adapter LRA-1 used for ruggedized mounting, with or without chassis slides, is available, as well as rack adapter LRA-2 which is used for simple rack installations where chassis slides are not required. See figure 12.

Overvoltage Protector..... Externally mounted overvoltage protectors LHOV-4, LHOV-5, LHOV-6 are available for use with Lambda LK 340A—LK 345A power supplies. The overvoltage protector prevents damage to the load that can be caused by excessive power supply output voltage.

MODEL OPTIONS

Suffix "FM" Meter Option... Standard LK power supplies can be obtained with voltmeter and ammeter.

Suffix "V" Input Option..... Standard LK power supplies can be obtained for operation with 205-265 volt or 187-242 volt, 57-63 Hz input. See nameplate for AC input rating. See schematic diagram for rewiring of AC input. For 47-57 Hz derate current 10%.

Suffix "R" Fungus Proofing Option. . . Standard LK power supplies can be obtained with fungus proofing treatment with MIL V 173 varnish for all fungi nutrient components.

THEORY OF OPERATION

GENERAL

The Lambda power supply consists of an AC input circuit and transformer; a pre-regulator circuit consisting of rectifiers, SCR(s) and filters; a preregulator control circuit containing auxiliary rectifiers and filters, a ramp generator, a ramp gate, a comparator, a reference zener and an SCR gate trigger generator; a series regulator control circuit containing a reference supply circuit consisting of rectifier, filter, prereference zener and reference zener, in addition to a 1st emitter-follower driver, a constant current generator, a current regulator comparator, a voltage-current amplifier, a voltage regulator comparator and an output sensing divider; a main regulator circuit consisting of a series regulator, the 2nd emitter-follower driver and a constant current pre-load.

The circuit arrangement is shown in block diagram form in figure 9. The circuitry is discussed with reference to the block diagram and the schematic diagram.

FUNCTIONAL DESCRIPTION

Single phase input power is applied to transformer T1 through the input circuit containing thermostat S2 and fuse F1, which protect the supply against overheating and internal faults respectively.

The pre-regulator, an SCR-type regulator and rectifier, contains the full-wave main rectifier that provides the power which is filtered by the capacitors and then regulated via a series regulator and delivered to the output. The full-wave auxiliary rectifier CR111-CR114 provides voltage filtered by capacitors C111, C112 for ramp generator Q131, comparator Q151, and SCR gate trigger generator Q171 as well as for reference zener diode CR151. The reference supply half-wave output from CR275 is filtered by capacitor C271 and converted into a contant current by a circuit comprised of transistor Q271, resistor R278 and zener diode regulator CR274. Prereference zener diode CR273 converts the reference supply output into a contant voltage to further regulate the current through reference zener CR271. The difference in voltage between diodes CR273 and CR271 is used as a reference voltage for constant current generator Q253, which sets the reference current for current controls R302A, B. The reference supply also provides regulated B+ voltage for current regulator comparator Q251, Q252, amplifier Q231 and voltage regulator comparator Q211, Q212.

The function of the preregulator control circuit is to regulate the voltage across the series regulator transistors at some constant value regardless of line voltage and/or output voltage variation. Constant current source Q131 charges capacitor C131, which is in turn discharged at the end of each half-cycle of input power by ramp gate Q132, resulting in a repetitive ramp signal. The series regulator transistor voltage is compared with the ramp signal, the voltage reference CR151 and an SCR frequency balancing signal by comparator Q151, and the output is used to control SCR gate trigger generator Q171. The balancing signal is sensed at the anode(s) of the SCR(s) through diodes CR172 (CR174) and the associated R-C network. When a trigger signal is generated by Q171, the SCR gate is triggered on, turning on SCR301 and transferring AC power from the main secondary windings of T1 to DC power in the filter capacitors. For units with two SCR's, each SCR functions only on every other half cycle of input power instead of on each half cycle as is the case with single SCR units.

Constant current pre-load Q301 provides a path for the series-regulator transistor leakage current, regardless of variation in output voltage and input line voltage. Diode CR301 is used to provide collector voltage for C. C. pre-load Q301 when output voltage is at zero.

Constant voltage circuit operation is determined by changes in the output voltage. A change in output voltage is sensed by sensing divider R301A, B, R271, R272, which has a fixed current flowing in the divider elements, as determined by the setting of calibration control R272. This variation in output is compared with the reference voltage of zener CR271, which results in an error voltage at the junction of R301B and R272. The error voltage is amplified by voltage regulator comparator Q211, Q212, further amplified by amplifier Q231 and is current amplified by emitter-follower drivers Q232 and Q302.

In constant voltage operation the voltage across the emitter resistors is less than the preset voltage across R302A, B; Q251 is in saturation, CR232 is at cutoff; and CR231 is conducting. If the load current decreases, causing a rise in output voltage, Q211 conducts less, Q212 is biased toward cutoff and more current flows through diode CR231 instead of Q212. This action causes amplifier Q231 to conduct more heavily, reducing drive current to emitter-follower drivers Q232, Q302, causing the series regulator impedance to increase and the output voltage to decrease accordingly.

Simultaneously, Q252 of the current regulator comparator samples load current through the series-regulator, emitter resistor and compares it with the preset voltage across CURRENT LIMITER resistors R302A, B that is produced by current control generator Q253. Constant voltage mode of operation automatically changes to constant current mode of operation when the output current increases and equals the pre-set current limit level. The upper limit is determined by calibration control R255. An increase in output current causes the voltage drop across the emitter resistors to equal the pre-set voltage across resistors R302A, B, a primary condition during constant current operation. In addition Q251 is now biased toward cutoff and current flows through zener diode CR232, causing Q231 to conduct more heavily, reducing drive current to Q232 and Q302, causing the series regulator impedance to increase and the output voltage to decrease accordingly, effectively maintaining a constant current. This output voltage decrease, sensed by the voltage sensing divider, causes turn-on of Q212 until saturation occurs and diode CR231 stops conducting. The unit now continues to function in the constant current mode of operation with zener diode CR232 controlling the turn-on bias of amplifier Q231, which in turn controls the drive current to the series regulator and ultimately the output voltage of the supply. Zener diode CR232 is also used to offset DC power line voltage drops which occur when operating the unit with remote sensing.

OPERATING INSTRUCTIONS

CONTROLS, INSTRUMENTS AND FUSES

ON-OFF Switch. The ON-OFF switch, located on the front panel, controls application of input power to the supply. When the switch is in the ON position, the red indicator glows.

OUTPUT VOLTAGE Control. The OUTPUT VOLTAGE control is a dual control consisting of a coarse adjustment potentiometer, which varies the DC voltage over a range 0-19, 0-35 or 0-59 volts, as applicable, and a fine adjustment potentiometer, which varies the DC voltage over a one-volt range. Clockwise rotation results in increasing voltage. The total DC voltage output for voltage regulated operation, is equal to the sum of each shaft setting; for current regulated operation the maximum voltage limit is equal to the sum of each shaft setting. The control is located on the front panel of all units.

CURRENT LIMITER Control. The CURRENT LIMITER control is a dual control consisting of a coarse adjustment potentiometer, which varies the DC current over 90% of the rated current range and a fine adjustment potentiometer, which varies the DC current over 10% of the rated current range. Clockwise rotation results in increasing current. The total DC current output for current regulated operation, is equal to the sum of each shaft setting; for voltage regulated operation the maximum current limit is equal to the sum of each shaft setting. The control is located on the front panel of all units.

Output Voltage Meter. A DC voltmeter monitors the voltage at the output terminals of metered (FM) units for the rated voltage range.

Output Current Meter. A DC ammeter monitors the load output current of metered (FM) units for the rated current range.

Fuses Fuse F1, internally located, is a 3AG "SLO-BLO" fuse which functions in the AC input circuit.

Fuse F2, internally located, is a 4AG standard fuse which protects the load from excessive output current that can be caused by internal circuit failure.

NOTE: For fuse values see fuse chart in SPECIFICATIONS AND FEATURES

Connection Terminals. Make all connections to the supply at the terminal block on the rear of the supply. Apply input power through the line cord or directly to terminals 1 and 2 if the line cord is removed. Always connect the ungrounded (hot) power lead to terminal 1.

The supply positive terminal is brought out to terminal 6. The supply negative terminal is brought out to terminal 4. Recommended wiring of the power supply to the load and selection of wiring is shown in figures 1 through 8. Selection of proper wiring is made on the basis of load requirements. Make all performance checks and measurements of current or voltage at the rear output terminals. Connect measuring devices directly to terminals or use the shortest leads possible.

GROUND CONNECTIONS

The Lambda power supply can be operated either with negative or positive output terminal grounded or with no terminal grounded. Both positive and negative ground connections are shown in the diagrams for all suggested output connections illustrated in this manual.

> NOTE: When operating the supply with neither terminal grounded, high impedance leakage resistance and capacitance paths can exist between the power supply circuitry and chassis ground.

BASIC MODES OF OPERATION

This power supply is designed to operate as a constant voltage source or as a constant current source. Automatic crossover to either mode of operation occurs when load conditions change as follows:

Constant Voltage. The power supply will function as a constant voltage source while the load current does not equal the current value, I_{LIM}, set by the CURRENT LIMITER control. When load current $I_L = \frac{V}{R_L} = I_{LIM}$, the supply will cross over automatically and will operate as a constant current source. Further decrease in value of load resistance R_L results in decrease of voltage across the load while current remains regulated to I_{LIM}.

Constant Current (Automatic Crossover). The power supply will function as a constant current source while the load voltage V_L does not equal the voltage value set by the OUTPUT VOLTAGE control. When load voltage V_L equals the value set by the OUTPUT VOLTAGE control, the supply will automatically cross over and operate as a constant voltage source.

SUPPLY-LOAD CONNECTIONS

> NOTE: Refer to DETAILED OPERATING PROCEDURES for step-by-step instructions for operation of power supply.

CONNECTIONS FOR OPERATION AS A CONSTANT VOLTAGE SOURCE

The regulation of the power supply at the load may change when using the supply as a constant voltage source and connecting leads of practical length are used. To minimize the effect of the output leads on this characteristic, remote sensing is used. Recommended types of supply-load connections with local or remote sensing are described in the following paragraphs.

Refer to figure 1 to determine voltage drop for particular cable length, wire size and current conditions. Lead lengths must be measured from supply terminals to load terminals as shown in figure 2.

Two-Wire Connection, Figure 3. The two-wire connection with local sensing, provides simplest connection suitable for applications with relatively constant load.

Four-Wire Connection, Figure 4. The four-wire connection with remote sensing, provides complete compensation for the DC voltage drops in the connecting cables. Compensation for lead drop is also valid for gradual changes of load current. Sensing leads should be a twisted pair to minimize AC pick-up. A 2.5 mf, elect.,, capacitor may be required between output terminals and sense terminals to reduce noise pick-up.

Programmed Voltage Connections, Using External Resistor, Figure 5. Discrete voltage steps can be programmed with a resistance voltage divider valued at 200 ohms/volt output and a shorting-type switch as shown in figure 5. When continuous voltage variations are required, use a variable resistor with the same 200 ohms/volt ratio in place of the resistive voltage divider and shorting-type switch. Use a low temperature coefficient resistor to assure most stable operation.

As shown in figure 5, voltages can be programmed utilizing either local or remote sensing connections, as desired.

Programmed Voltage Connections Using Programming Voltage, Figure 6. The power supply output voltage can be programmed with an externally connected programming power supply. The output voltage of the programmed supply will maintain a one-to-one ratio with the voltage of the programming supply.

The programming supply must have a reverse current capability of 6 ma. minimum.

Alternatively, when supplies with less than 6 ma. reverse current capability are used, a resistor capable of drawing 6 ma. at the minimum programming voltage must be connected across the output terminals of the supply. This programming supply must be rated to handle all excess resistor current at the maximum programming voltage.

CONNECTIONS FOR OPERATION AS A CONSTANT CURRENT SOURCE

Automatic Crossover Constant Current Connections, Figure 3. Figure 3 shows the connections which are used when operating the power supply as a constant current source with automatic crossover, using local setting of current control.

In this mode of operation, when the load voltage increases, due to changing load resistance, to the limit of the OUTPUT VOLTAGE control setting, the power supply crossover circuit will cause the unit to operate as a constant voltage supply.

CONNECTIONS FOR SERIES OPERATION

The voltage capability of LK power supplies can be extended by series operation of LK power supplies of equal or unequal voltage ratings. A maximum of 200 volts can be connected between either the +DC or -DC terminal and chassis ground.

Two units are shown connected for series operation in figure 7. Figure 7 shows the series connection diagram which would be suitable for use in all applications.

Diodes CR_M and CR_S, which protect the units against reverse voltage, must be capable of withstanding the maximum rated current.

The series connection permits operation for either constant voltage or constant current with automatic crossover to either mode of operation whenever the respective limiting operating current or voltage is reached. Figure 7 shows connection for either local or remote sensing, when the series combination is operated for constant voltage; figure 7a shows the connection required when the series combination is operated for constant current.

CONNECTIONS FOR PARALLEL OPERATION

The current capability of LK power supplies can be extended by parallel operation of two LK power supplies of equal* voltage capacities. The two units are shown connected for parallel operation in figure 8. One power supply designated the (M) unit controls its own output as well as the output of the second power supply, designated the (S) unit.

Unit (S) operates to regulate its current in a ratio to that of the (M) unit by comparing the current in its internal sampling resistor with that current sampled by the master internal sampling resistor. When power supplies of unequal current capacities are parallel connected the division of current supplied will be approximately equal to the ratio of the current ratings of the supplies.

Parallel connected units can be operated for constant voltage with local sensing as well as for constant current with automatic cross-over. When operating for constant voltage, the (M) unit can automatically cross over into constant current operation.

DETAILED OPERATING PROCEDURES

SAFETY NOTICE

DANGEROUS VOLTAGES EXIST IN THIS EQUIPMENT. OBSERVE THE USUAL SAFETY PRECAUTIONS WHEN OPERATING OR SERVICING THE EQUIPMENT TO AVOID SHOCK OR INJURY.

CONSTANT VOLTAGE OPERATION, ADJUSTABLE CURRENT LIMIT

1. Remove AC power input to supply and place ON-OFF switch in OFF position before connecting load to the supply.

2. Determine load requirements, select wire size from figures 1 and 2 and choose desired type of supply-load connection from figures 3 and 4.

3. Connect supply to load as shown on the selected connection diagram.

NOTE: When shipped from the factory, the supply is ready for use as a constant current source with automatic crossover or as a local-sensing constant voltage source. Jumpers are connected at the factory as shown in figure 3. Take care to remove the appropriate jumpers for load requirements that need different supply-load connections. Refer to the appropriate connection diagram.

4. Turn OUTPUT VOLTAGE control knobs to the desired voltage setting.

5. When current to the load must be limited to an intermediate value within the current rating of the supply, turn the CURRENT LIMITER control knobs to the desired current limit setting. If no intermediate current limit is required, turn the control knobs CW to the position for full current rating for the maximum ambient temperature of operation. Refer to section on specifications.

*For applications using supplies of unequal voltage ratings, consult factory for details of operation.

6. Apply AC power to supply

7. Place ON-OFF switch in ON position and check that red indicator is lit.

8. Check that output current and output voltage meters indicate desired values; as required, adjust OUTPUT VOLTAGE control knobs and CURRENT LIMITER control knobs to obtain correct meter indications. For non-metered models use externally connected meters and check that correct meter indications exist at output terminals 6 and 4; for remote sensing connections, check at the load terminations of sensing leads on terminals 3 and 7.

9. Power supply is now in proper operation.

PROGRAMMED CONSTANT VOLTAGE OPERATION, ADJUSTABLE CURRENT LIMIT

1. Remove AC power input to the supply and place ON-OFF switch in OFF position before connecting load to the supply.

2. Determine load requirements, select wire size and length from figures 1 and 2. Choose desired type of supply-load connection from figures 5 or 6. Refer to paragraph on Programmed Voltage Connections.

3. Connect supply to load as shown on the selected connection diagram. As shown in figure 5, take care to use a shorting-type switch for the external programming control when several voltages are desired and the programming voltage method is not used.

4. Turn OUTPUT VOLTAGE control knobs to the extreme CCW position. Adjust external programming voltage control to desired voltage setting.

5. When current to the load must be limited to an intermediate value within the current rating of the supply, turn the CURRENT LIMITER control knobs to the desired current limit setting. If no intermediate current limit is desired, turn the control knobs CW to the position for full rated current for the ambient temperature of operation. Refer to section on specifications.

6. Apply AC power to the supply.

7. Place ON-OFF switch in ON position and check that red indicator is lit.

8. Check that output current and output voltage meters indicate desired values; as required, adjust CURRENT LIMITER knobs and external programming voltage control to obtain correct meter indications. For non-metered models use externally connected meters and check that correct meter indications exist at output terminals 4 and 6; for remote sensing connections check at the load terminations of sensing leads on terminals 3 and 7.

9. Power supply is now operating properly.

CONSTANT CURRENT OPERATION WITH CROSSOVER, ADJUSTABLE VOLTAGE LIMIT

1. Remove AC power input to the supply and place ON-OFF switch in OFF position before connecting load to the supply.

2. Determine load requirements and connect load to the supply as shown in figure 3.

3. Turn the CURRENT LIMITER knobs to the desired current setting.

4. When load voltage must be limited to an intermediate value within the voltage rating of the supply, turn OUTPUT VOLTAGE control knobs to the desired voltage limit setting. If no intermediate voltage limit, within rating of supply is desired, turn control knobs to the full CW position to obtain voltage limit at maximum voltage rating of the supply.

5. Apply AC power to the supply.

6. Place ON-OFF switch in ON position and check that red indicator is lit.

7. Check that output current and output voltage meters indicate desired values; adjust OUTPUT VOLTAGE control knobs and CURRENT LIMITER control knobs as required to obtain correct indications. For non-metered models use externally connected meters and check that correct meter indications exist at output terminals 4 and 6.

8. Power supply is now in proper operation.

SERIES CONNECTION CONSTANT VOLTAGE OPERATION, WITH CURRENT LIMIT

1. Remove AC power input to the (B) and (A) units, figure 7, and place ON-OFF switches in OFF position before connecting load to the supplies.

2. Determine load requirements, select wire size from figures 1 and 2 and choose correct type of series supply-load connections from figure 7. Refer to paragraph on Connections for Series Operation.

3. Connect supply to load as shown on the selected connection diagram. As required, select diodes CR_S and CR_M in accordance with instructions contained in Connections for Series Operation.

4. Turn (A) and (B) unit OUTPUT VOLTAGE control knobs to the desired total voltage setting.

5. When current to the load must be limited to an intermediate value within current rating of the units, turn each CURRENT LIMITER control knob to the desired setting. If no intermediate current limit is required, turn the control knobs of each unit CW to the position for full current rating for the maximum ambient temperature of operation. Refer to section on specifications.

> NOTE: When units of unequal current rating are series connected, the unit with the lower current rating must be capable of delivering the desired load current.

6. Apply AC power to the supplies.

7. Place ON-OFF switches of both units in ON position and check that red indicators are lit .

GENERAL DESCRIPTION

Rack adapter LRA-1 is designed for use in equipment racks where ruggedized mounting of units is required. The adapter can be used with or without chassis slides.

Rack adapter LRA-2 is designed for simple applications of rack installation where chassis slides and ruggedized mounting of equipment are not required.

Both rack adapter LRA-1 and LRA-2 can be used to install 1/4-rack or 1/2-rack power supply units into equipment racks. Each adapter can accept various combinations of 1/4 and 1/2-rack units up to four 1/4-rack units or two 1/2-rack units.

INSTALLATION OF 1/2 RACK UNITS INTO LRA-1

To install 1/2-rack power supply units, remove slide numbers 2 and 3 and/or 6 and 7, together with securing hardware and associated slide bar nut.

Using slide screws and slide bar nuts that were removed, store removed slides on the frame at the rear of the adapter where screw clearance holes are provided for securing each slide to the adapter.

SHIPMENT OF UNITS MOUNTED IN LRA-1

To protect the unit against damage from shock and vibrations when transporting adapter with installed units, eight universal tie-down mounting holes, located in the adapter base, at the rear of the rack adapter, are used to secure 1/4-rack and/or 1/2-rack units into the rack adapter. Secure each unit using two 6-32 x 5/8 screws, two lock-washers and two spacers installed from the bottom side of the rack adapter. See detail A for typical securing hardware. Eight spacers are supplied with rack adapter LRA-1.

RUGGEDIZED MOUNTING

When ruggedized mounting of units is required, follow the procedure described for SHIPMENT OF UNITS MOUNTED IN LRA-1. See detail A for typical securing hardware.

MOUNTING CHASSIS SLIDES

Mount chassis slides uning the following hardware. To assure unrestricted mounting of units into the adapter designated screw lengths must not be exceeded. Insert screws into designated holes and secure slide in position using long bar nut supplied with rack adapter LRA-1.

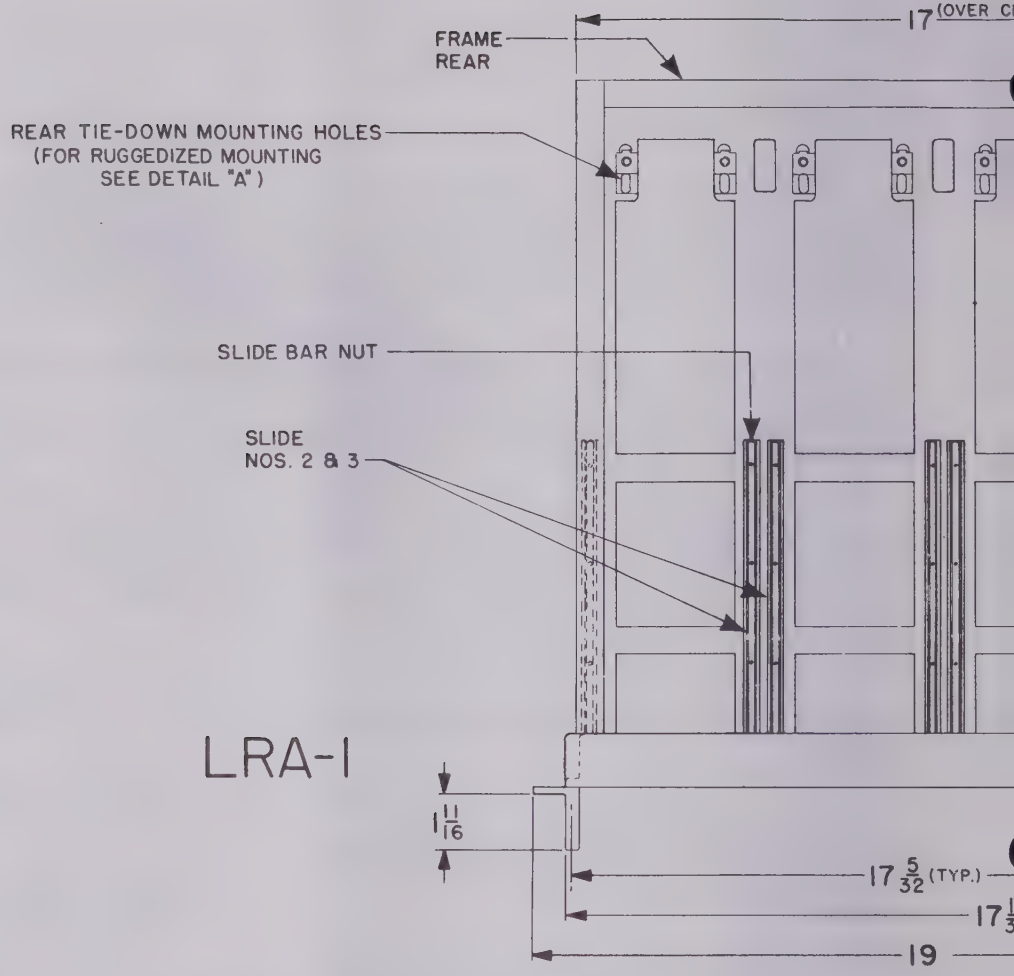
CHASSIS TRAK NO. CTS. -116:
10-32 x 7/16 fl-hd (82°);
use A holes.

LAMBDA NO. KHT-34-003 (1 PR)
6-32 x 3/8 pan-hd;
use B, C, and D holes.

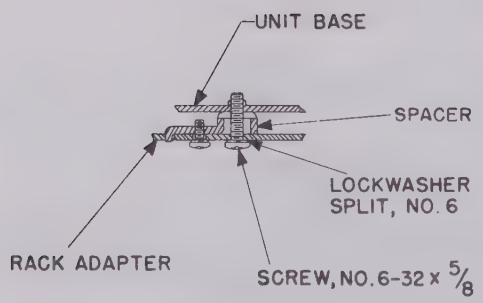
GRANT PULLEY NO. 4435:
6-32 x 5/15 fl-hd (100°);
use B and D holes.

USING BLANK PANELS

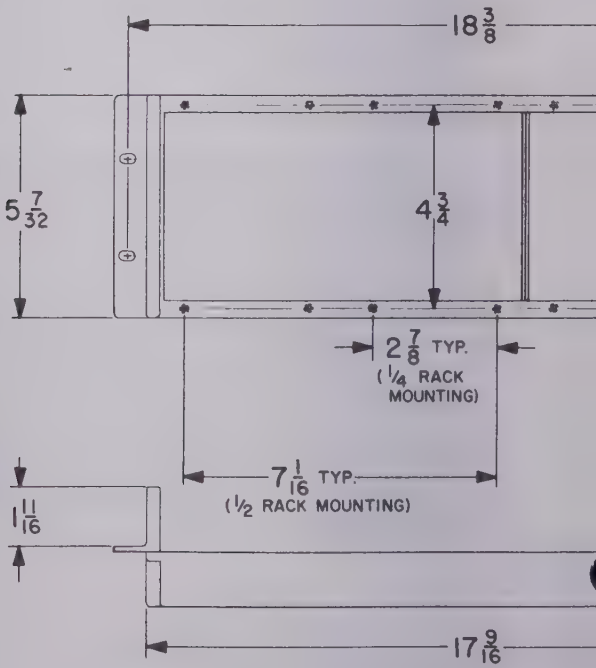
Blank front panels Model LBP-10 and LBP-20 are available for covering any 1/4-rack or 1/2-rack opening respectively. The blank panels can be used with rack adapter LRA-1 and LRA-2 whenever a 1/4-rack or 1/2-rack space in the adapter is not occupied by a unit. Secure each panel in position using four 6-32 x 3/8 pan-head screws supplied with the rack adapter.



LRA-1



DETAIL A



LRA-2

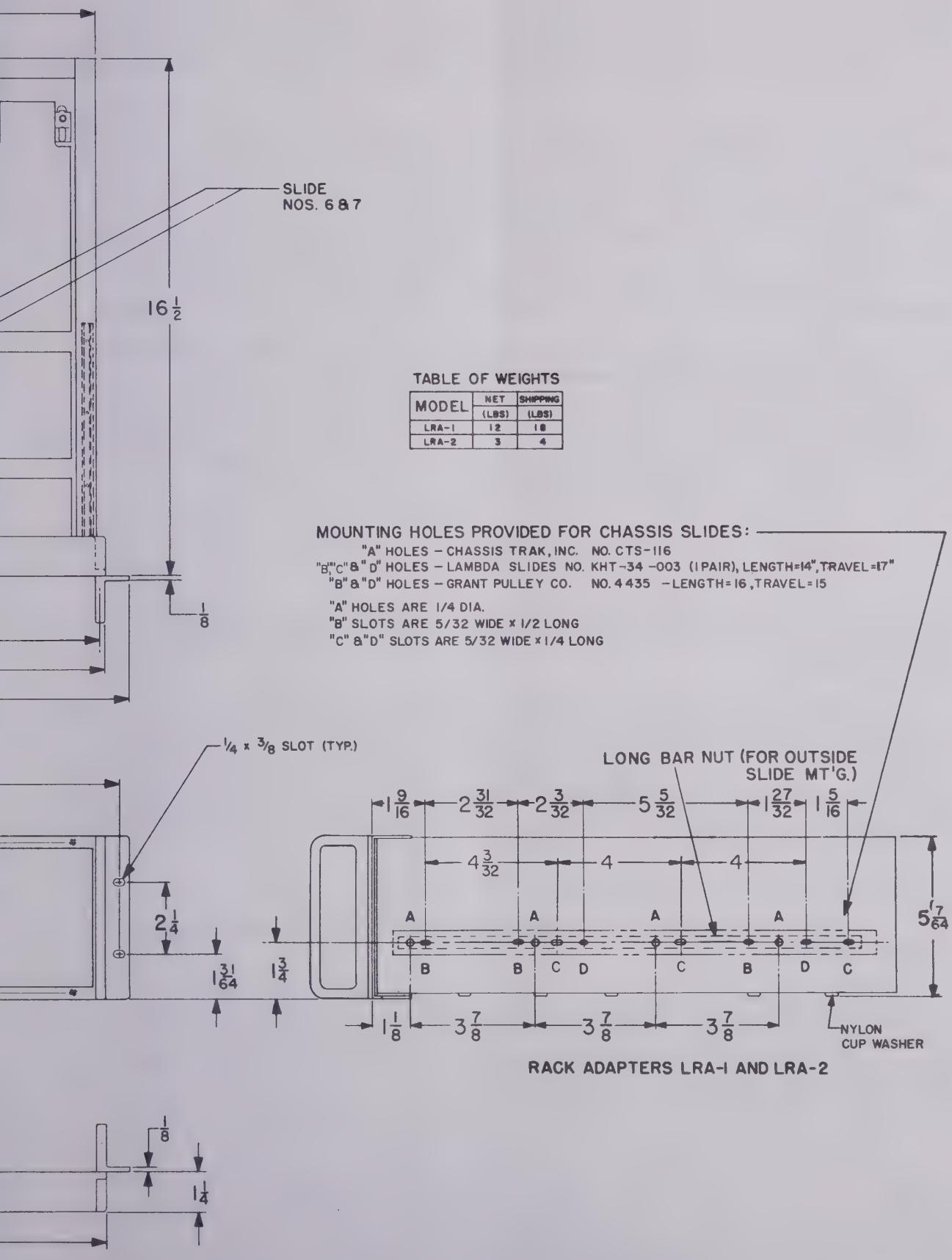


Figure 12. Rack Adapters LRA-1 and LRA-2

8. Check that output current and output voltage meters indicate desired values; total voltage is equal to sum of (A) and (B) units. As required, adjust OUTPUT VOLTAGE control knobs of both units to obtain correct indication; overload supply and adjust CURRENT LIMITER control knobs of both units to obtain correct indication. For non-metered models use externally connected meters and check that correct meter indications exist at output terminals of both units; positive (+) terminal of (A) unit and minus (-) terminal of the (B) unit are the output terminals of the series combination.

For remote sensing connection, make checks at the load terminations of sensing leads from terminal 7 of (A) and from terminal 3 connection of (B) unit.

9. Power supplies are now in proper operation.

PARALLEL CONNECTION CONSTANT VOLTAGE OPERATION, WITH CURRENT LIMIT

1. Remove AC power input to each supply and place ON-OFF switch on both (M) and (S) units in OFF position before connection load to the supplies.

2. Determine load requirements, select wire size from figures 1 and 2 in the manual. Refer to paragraph on Connections for Parallel Operation.

3. Connect supplies to load as shown in connection diagram, figure 8.

> NOTE: When shipped from the factory, each supply is ready for use as a constant current source or as a local-sensing constant voltage source. Jumpers are connected at the factory. Take care to remove the appropriate jumpers for load requirements that need different supply-load connections. Refer to the appropriate connection diagram.

4. Turn OUTPUT VOLTAGE control knobs on the (M) unit to the desired voltage setting, and turn the OUTPUT VOLTAGE control knobs on the (S) unit to fully CCW position.

5. When current to the load must be limited to an intermediate point, turn the CURRENT LIMITER control knobs on both the (M) and (S) units to the desired current limit setting. Set current limit control on the (M) and (S) units to the position indicating the current value to be delivered by the respective unit. If no intermediate current limit is desired, turn the CURRENT LIMITER control knobs CW on both (M) and (S) units to the position for full rated current for the maximum ambient temperature of operation. Refer to section on specifications.

6. Apply AC power to each supply.

7. Place ON-OFF switches on (M) and (S) units in ON position and check that red indicators are lit.

8. Check that output current and output voltage meters on both (M) and (S) units indicate desired values; as required, adjust OUTPUT VOLTAGE control and CURRENT LIMITER control on (M) unit to obtain correct meter indications. For non-metered models use externally connected meters and check that correct meter indications exist at output terminals 4 and 6 of the (M) unit.

9. Power supplies are now in proper operation.

OPERATION AFTER PROTECTIVE DEVICE SHUTDOWN

Thermostat Shutdown

The thermostat opens the input circuit only when the temperature of the transistor heat radiator exceeds a maximum safe value. The thermostat will automatically reset when the temperature of the radiator decreases to safe operating value. After eliminating the cause(s) for overheating and allowing time for the power supply to cool to a proper temperature, resume operation of the supply. Refer to appropriate operation paragraph in DETAILED OPERATING PROCEDURES.

Fuse Shutdown

Internal failure of the supply causes the fuses to clear the circuit, removing input power from the supply. Overloading of unit will not cause fuse failures. Fuses will blow when the maximum rated current value for the fuse is exceeded. Fatigue failure of fuses can occur when mechanical vibrations from the installation combine with thermally induced stresses to weaken the fuse metal. Many fuse failures are caused by a temporary condition and replacing the blown fuse will make the fuse protected circuit operative.

MAINTENANCE

GENERAL

This section describes trouble analysis routine, replacement procedures, calibration and test procedures that are useful for servicing the Lambda power supply. Refer to the section on specifications and features for the minimum performance standards.

TROUBLE ANALYSIS

Whenever trouble occurs, systematically check all fuses, primary power lines, external circuit elements, and external wiring for malfunctions before trouble shooting the equipment. Failures and malfunctions often can be traced to simple causes such as improper jumper and supply-load connections or fuse failure due to metal fatigue.

Use the electrical schematic diagram and block diagram, figure 9, as an aid to locating trouble causes. The schematic diagram contains various circuit voltages that are averages for normal no-load operation. Measure these voltages using the conditions for measurement specified on the schematic diagram. Use measuring probes carefully to avoid causing short circuits and damaging circuit components.

CHECKING TRANSISTORS AND CAPACITORS

Check transistors with an in-circuit transistor checker. If no checker is available, transistors can be checked with an ohmmeter that has a highly limited current capability. Observe proper polarity for PNP or NPN to avoid error in measurement. The forward transistor resistance is low but never zero; backward resistance is always higher than the forward resistance.

Do not assume trouble is eliminated when only one part is replaced. This is especially true when one transistor fails, causing other transistors to fail. Replacing only one transistor and turning power on, before checking for additional defective components could damage the replaced component.

When soldering semi-conductor devices, hold the lead being soldered with a pair of pliers placed between the component and the solder joint to provide an effective heat sink.

NOTE: The leakage resistance obtained from a simple resistance check of a capacitor is not always an indication of a faulty capacitor. In most cases the capacitors are shunted with resistances, some of which have low values. Only a dead short is a true indication of a shorted capacitor.

PRINTED CIRCUIT BOARD MAINTENANCE TECHNIQUES

1. If foil intact but not covered with solder it is a good contact. Do not attempt to cover with solder.

2. Voltage measurements can be made from either side of the board. Use a needle-point probe to penetrate to the wiring whenever a protective coating is used on the wiring. A brass probe can be soldered to an alligator clip adapted to measuring instrument.

3. Always use a heat sink when soldering transistors; a transistor pad with mounting feet is an effective heat sink.

4. Broken or damaged printed wiring is usually the result of an imperfection, strain or careless soldering. To repair small breaks, tin a short piece of hook-up wire to bridge the break, and holding the wire in place, flow solder along the length of wire so that it becomes part of the circuitry.

5. When unsoldering components from the board never pry or force loose the part; unsolder the component by using the wicking process described below:

(a) Select a 3/16 inch tinned copper braid for use as a wick; if braid is not available, select AWG No. 14 or No. 16 stranded wire with 1/2 inch insulation removed.

(b) Dip the wick in liquid rosin flux.

(c) Place the wick onto the soldered connection and apply soldering iron onto the wick.

(d) When sufficient amount of solder flows onto the wick, freeing the component, simultaneously remove iron and wick.

TROUBLE CHART

The trouble chart is intended as a guide for locating trouble causes, and is used along with the schematic diagram.

The operating conditions assumed for the trouble chart are as follows:

(a) AC power of proper voltage and frequency is present at input terminals.

(b) Either positive or negative terminal is connected to chassis ground.

(c) The power supply is connected for constant voltage with local sensing. See schematic; dotted lines indicate jumpers connected for local sensing operation.

TROUBLE CHART

	Symptom	Probable Cause	Remedy
1.	Power ON-OFF lamp DS1 does not light with ON-OFF switch in ON position; no output voltage	No power input; ON-OFF switch defective; defective fuse F1; thermostat S2 open, fuse F1 blown	Check power source, line cord and line plug; replace S1, replace F1; Shut off unit, allow to cool and check ambient temperature
			Replace F1; if it blows immediately, as applicable, check diodes CR 305, CR306 (CR307, CR308) for shorts, SCR301 (SCR302) C305, (C306) for short, replace as necessary
2.	Unable to adjust output voltage	Damaged OUTPUT VOLTAGE controls	Check R301 A, B for shorts and/or open; replace as necessary
		Supply operating as constant current source with crossover at CURRENT LIMITER setting	Remove load and check for shorts and/or improper supply-load connections; refer to appropriate diagram for correct connections
3.	Zero volts DC output, with ON-OFF indicator DS1 lit	OUTPUT VOLTAGE controls turned fully CCW	Check OUTPUT VOLTAGE controls for proper setting and correct as necessary
		Short circuit across output of supply	Check load and load connections; correct as required
		Rectifiers CR305, CR306 (CR307, CR308) open, SCR301 (SCR302) open or gate of SCR(s) open or shorted	Check and replace as required
		Q151, Q171, CR111-CR114 open; CR151 C111 shorted	Check and replace as required
		C.C. pre-load Q301 shorted; Q302, CR301 open	Check and replace as required
		Q211 shorted, Q212 open; Q231 shorted; Q232 open; Q251 open Q252 shorted; CR232 shorted; R272 open	Check and replace as required

	Symptom	Probable Cause	Remedy
4.	Output intermittent or no output	Thermostat S2 activated by high temperature condition at series regulator transistor mounting	Check output current setting for agreement with rating at ambient temperature and adjust accordingly
5.	High ripple at line frequency or twice line frequency and high unregulated DC output	2nd driver Q302 and series regulator transistors shorted; Q211 open, Q212 shorted; Q231 open; Q232 shorted; CR271 open	Check appropriate component and replace as necessary
		Defective main rectifier causes ripple at twice line frequency	Check CR305 (CR306) in addition to Q302-Q306 and Q231 and replace as necessary
6.	Low unregulated DC output with high ripple	Line voltage too low	Check and correct AC input voltage at supply terminals
7.	Low unregulated DC output with low ripple	CURRENT LIMITER controls improperly adjusted	Check current setting on unit and adjust current controls for correct indication
		Load resistance incorrect for unit rating	Check value of load resistance for compatibility with power supply ratings
		CURRENT LIMITER controls R302 A, B defective	Check and replace R302 A, B as required
8.	Regulation is poor when operating in constant current mode	Insufficient voltage compliance	Refer to appropriate procedure for constant current operation and adjust OUTPUT VOLTAGE controls for correct indication
9.	Large spikes evident at output	Capacitor C311 open	Check and replace C311 as required
10.	High ripple	Improper ground connection	Connect terminal 4 or terminal 6 to ground terminal 5

ADJUSTMENT OF CALIBRATION CONTROLS

Whenever parts are replaced, adjust calibration controls only when voltage and current indications are improper and do not reflect maximum ratings.

Adjust Maximum Output Voltage Set Control R272 as Follows

1. Remove AC power input to the supply and place ON-OFF switch in OFF position.

2. Unsolder wiper of R272 from resistor housing.

3. Operate the power supply for constant voltage with local-sensing jumpers connected as shown in figure 3, and no external load.

4. Turn OUTPUT VOLTAGE control knobs fully clockwise and, using a DC voltmeter of 0.1 percent accuracy or better, adjust R272 to provide output voltage E_0 MAX + 0.20 volts; where E_0 MAX is the rated output voltage of the supply.

5. After adjustment is completed, remove AC power input to the supply and solder wiper of R272 to potentiometer housing.

Adjust Maximum Output Current Set Control R255 as Follows:

1. Remove AC power input to the supply and place ON-OFF switch in OFF position.

2. Unsolder wiper of R255 from resistor housing.

3. Turn OUTPUT VOLTAGE control knobs and CURRENT LIMITER control fully CW.

4. Operate the power supply for constant current crossover, connected as shown in figure 3, with a short circuit across the output terminals.

5. Adjust R255 for 105% of rated current output at 40°C ambient, using any DC ammeter of one percent accuracy or better.

6. After adjustment is completed, remove AC power input to the supply and solder wiper of R255 to potentiometer housing.

Adjust Series Regulator Voltage Set Control R152 as Follows:

1. Remove AC power input to the supply and place ON-OFF switch in OFF position.

2. Unsolder wiper R152 from resistor housing.

3. Turn OUTPUT VOLTAGE control knobs and CURRENT LIMITER control knobs fully CW.

4. Connect DC voltmeter of one percent accuracy or better, between output terminal 6 and collector at Q302.

5. Connect power supply for constant voltage operation with local sensing jumpers connected as shown in figure 3.

6. Connect resistive load. Calculate load value as follows:

$$R\ LOAD = \frac{E_{MAX}}{I_{MAX}\ \text{at}\ 40^{o}\ C}$$

7. Provide AC input power of 132 VAC to supply and place ON-OFF switch in ON position.

8. Adjust R152 until voltmeter indicates applicable voltage listed here for the appropriate LK model.

MODEL	VOLTMETER INDICATION
LK340, LK340A	10.0 VDC
LK341, LK341A	9.0 VDC
LK342, LK342A	11.0 VDC
LK343, LK343A	11.0 VDC
LK344, LK344A	11.0 VDC
LK345, LK345A	13.5 VDC

PERFORMANCE CHECKS

Checks With Constant Voltage Operation

Check the ripple and regulation of the power supply using the test connection diagram shown in figure 10. Use suggested test equipment or equivalent to obtain accurate results. Refer to SPECIFICATIONS AND FEATURES for minimum performance standards.

Set the differential meter, DC VTVM (Lambda power supply Model LS-515 with differential VM accessory Model LS-DM5 or equivalent) to the selected power supply operating voltage. Check the power supply load regulation accuracy while switching from the load to no-load condition. Long load leads should be a twisted pair to minimize AC pick-up.

Use a Variac to vary the line voltage from 105-132 or 132-105 volts AC and check the power supply line regulation accuracy on the VTVM differential meter.

Use a VTVM, Ballantine 320 or equivalent, to measure rms ripple voltage of the power supply DC output.

Checks With Constant Current Operation

Check the regulation of the power supply using the test connection diagram shown in figure 11. Refer to SPECIFICATIONS AND FEATURES for minimum performance standards.

Check the power supply load regulation accuracy while switching from the short circuit to load condition. Measure the voltage across sensing resistor Rs. Use Lambda power supply Model LS-515 with diffenential VM accessory Model LS-DM5 or equivalent for the VTVM connected across Rs. For Rs, use a resistor having value $Rs = \frac{1}{Iout}$

To obtain regulation figure, substitute values obtained into regulation formula:

$$\frac{\Delta E}{Rs} = \text{Regulation in milliamperes}$$

where ΔE is the voltage change in millivolts and Rs is the resistance of the sensing resistor.

Use a Variac to vary the line voltage from 105-132 or 132-105 volts AC and check the power supply line regulation accuracy using VTVM and the regulation formula:

$$\frac{\Delta E}{Rs}$$

SERVICE

When additional instructions are required or repair service is desired, contact the nearest Lambda office where trained personnel and complete facilities are ready to assist you.

Please include the power supply model and serial number together with complete details of the problem. On receipt of this information, Lambda will supply service data or advise shipping for factory repair service.

All repairs not covered by the warranty will be billed at cost and an estimate forwarded for approval before work is started.

PARTS ORDERING

Standard components and special components used in Lambda power supply can be obtained from the factory. In case of emergency, critical spare parts are available through any Lambda office.

The following information must be included when ordering parts:

1. Model number and serial number of power supply and purchase date.

2. Lambda part number.

3. Description of part together with circuit designation.

4. If part is not an electronic part, or is not listed, provide a description, function, and location of the part.

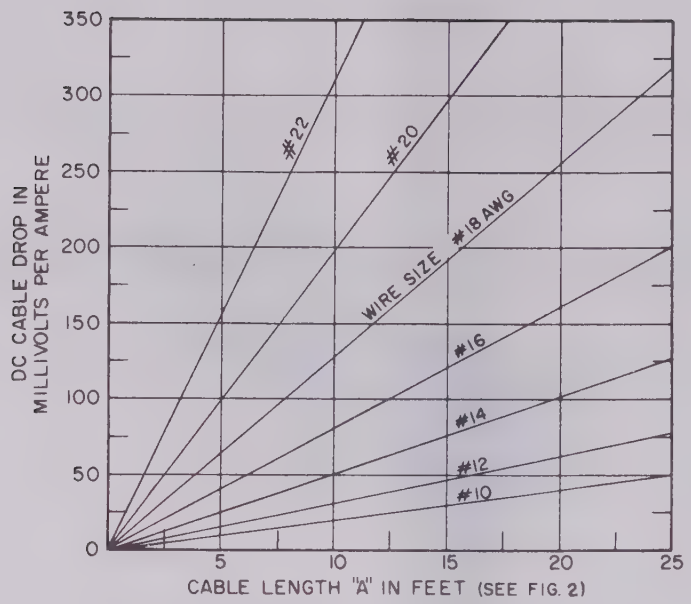


Figure 1. Cable Connection Chart

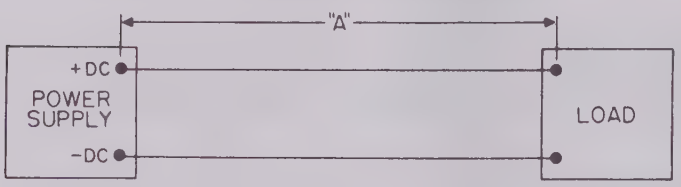
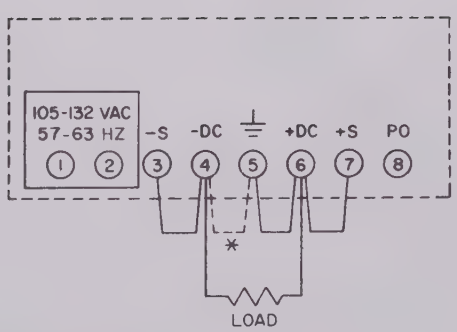
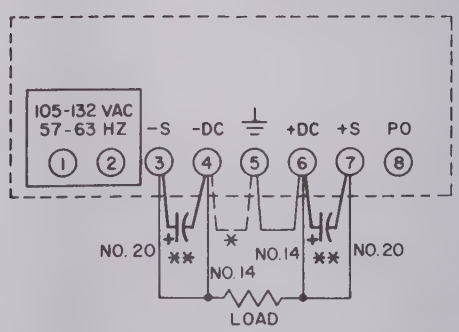


Figure 2. Cable Length "A" in Feet



NOTE:
* FOR NEGATIVE GROUND, DISCONNECT JUMPER FROM TERMINALS 5 AND 6 AND RECONNECT TO TERMINALS 4 AND 5.

Figure 3. Two-Wire Connection



NOTE:
* FOR NEGATIVE GROUND, DISCONNECT JUMPER FROM TERMINALS 5 AND 6 AND RECONNECT TO TERMINALS 4 AND 5.
** A 2.5 MF, ELECT., CAP. MAY BE REQUIRED.

Figure 4. Four-Wire Connection

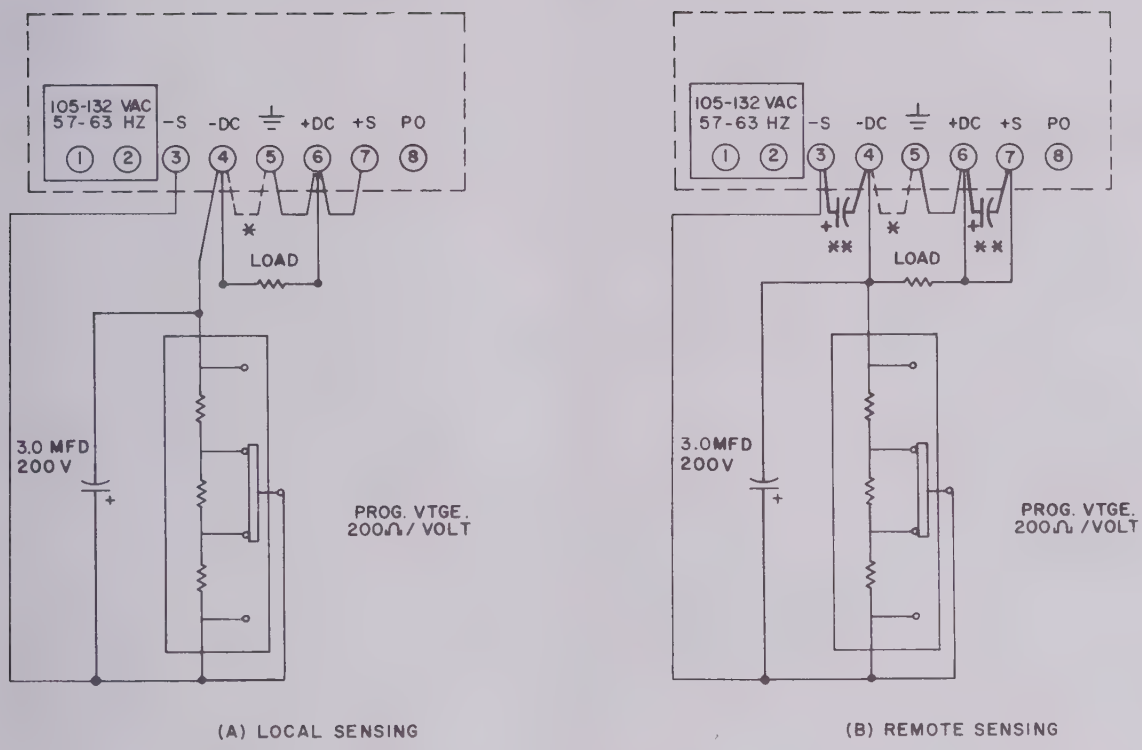


Figure 5. Programmed Voltage, With External Resistor

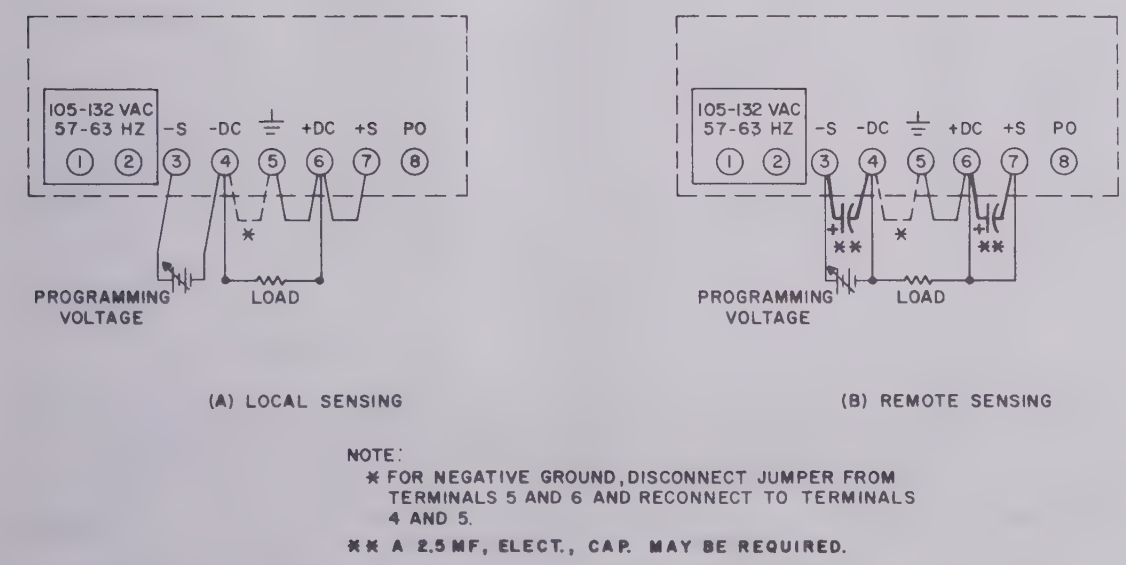
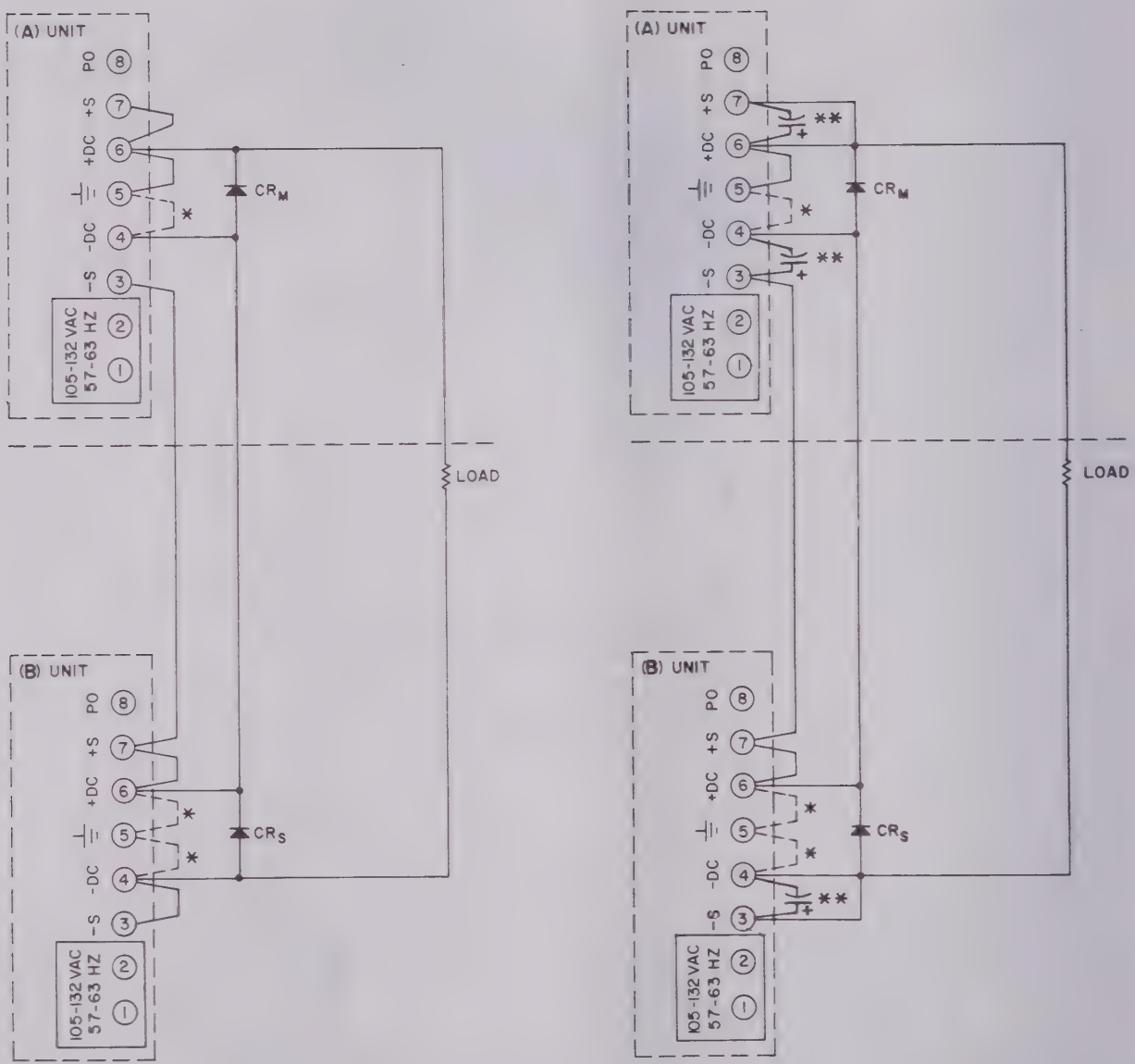


Figure 6. Programmed Voltage With External Programming Voltage Source

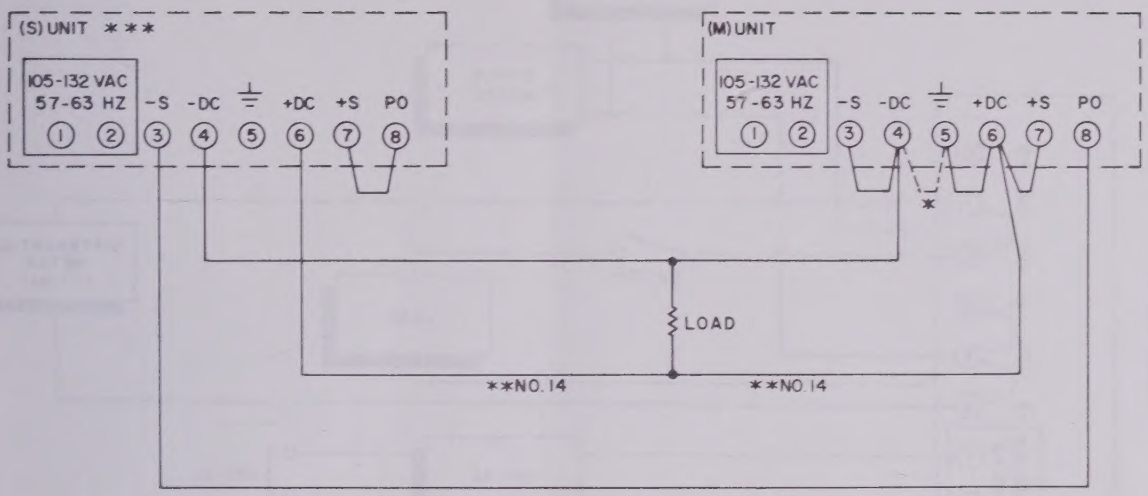


NOTE:

* MAKE ONLY ONE GROUND CONNECTION FOR THE SERIES COMBINATION; TO CHANGE GROUND AS SHOWN, REMOVE JUMPER FROM TERMINALS 5 AND 6 ON (M) UNIT AND CONNECT ANY ONE OF THE OTHER JUMPERS AS SHOWN IN DOTTED LINE.

** A 2.5MF, ELECT., CAP. MAY BE REQUIRED.

Figure 7. Series Connection



NOTE:
*FOR NEGATIVE GROUND, DISCONNECT JUMPER FROM TERMINALS 5 AND 6 AND RECONNECT TO TERMINALS 4 AND 5.
**FOR IMPROVED CURRENT BALANCING, THE "+DC" LEADS MUST BE THE SAME LENGTH AND SIZE.
***CAUTION: VOLTAGE CONTROLS OF (S) UNIT MUST BE SET FOR ZERO VOLTS OUTPUT.

Figure 8. Parallel Connection, Local Sensing

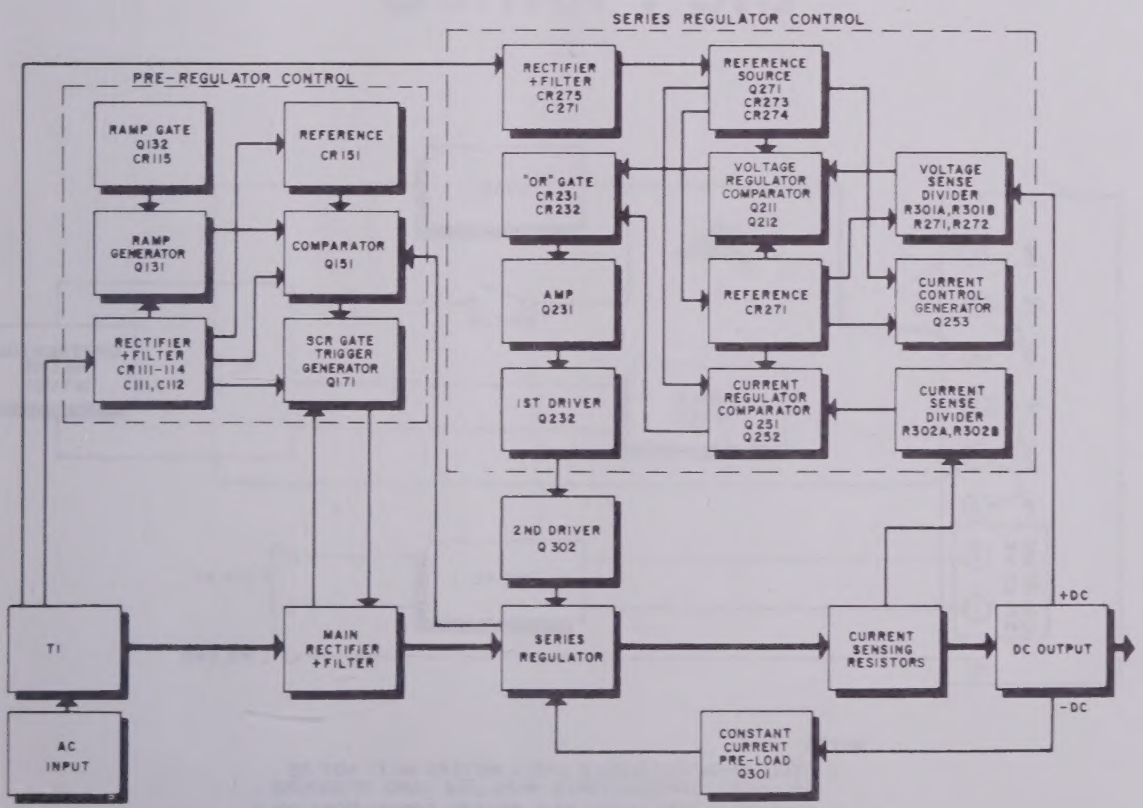


Figure 9. Typical Block Diagram

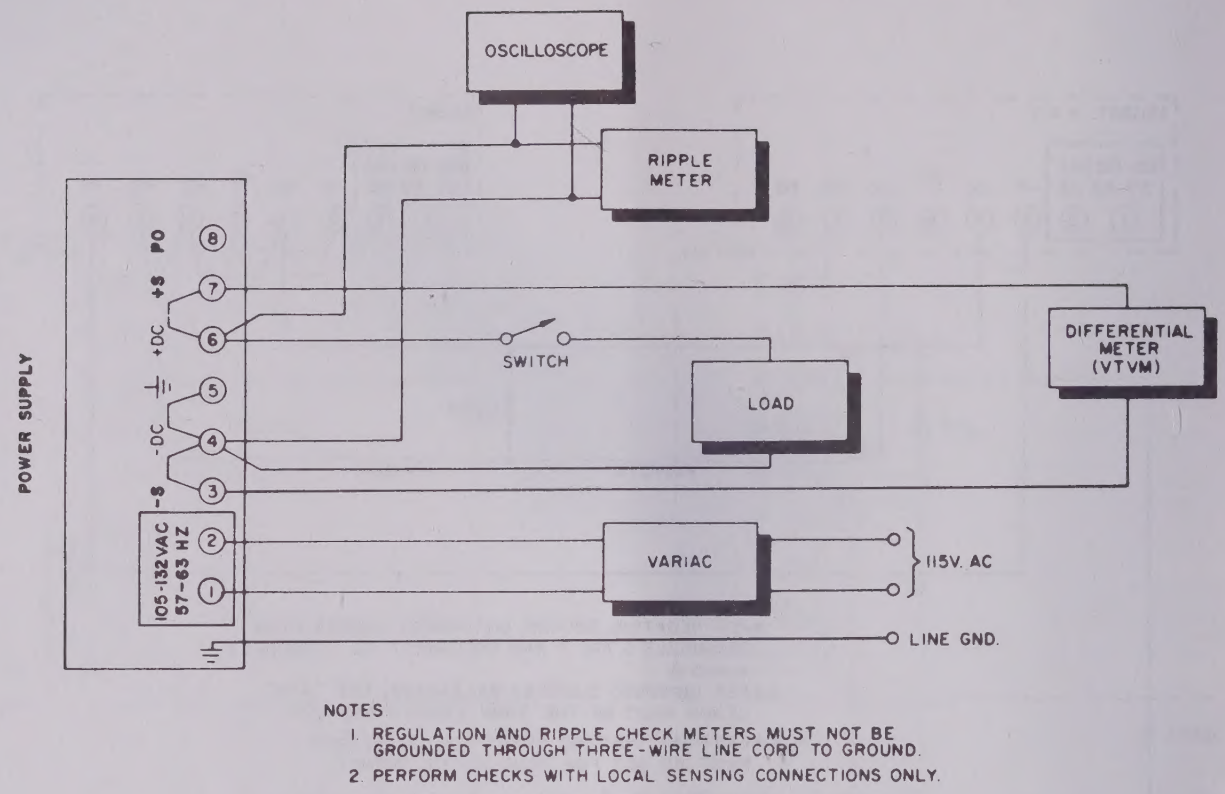


Figure 10. Test Connections For Constant Voltage Performance Checks

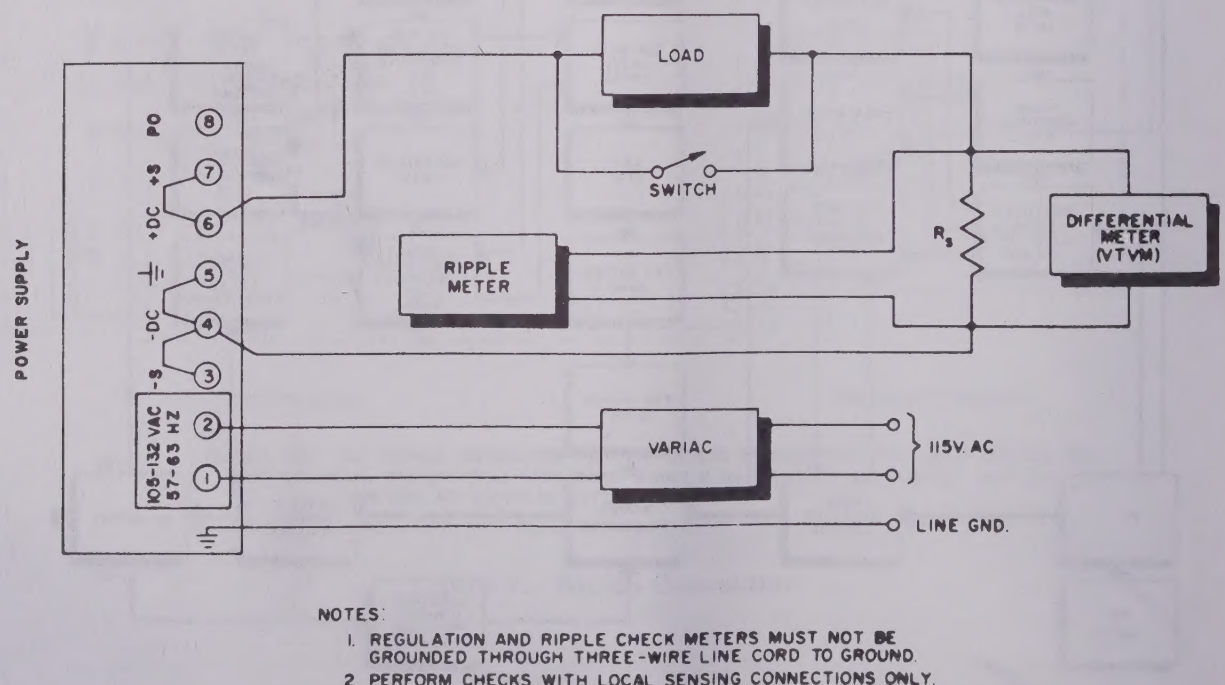


Figure 11. Test Connections For Constant Current Performance Checks

Figure 12
Located at
Center Fold

LAMBDA QUALITY

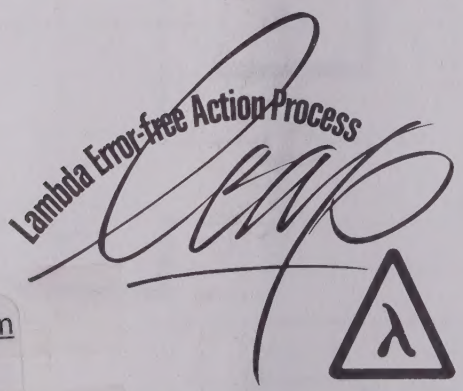
DEFINITION

Quality at Lambda means error-free output which meets the needs and exceeds the expectations of our internal and external customers.

IMPLEMENTATION

It is each individual's responsibility to understand his or her customers' needs and expectations and deliver products and services which achieve Lambda Quality.

LAMBDA



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